preferred embodiment of the present invention, while still providing a giant magnetoresistive (GMR) sensor element in accord with the spirit and scope of the present invention, as defined by the appended claims.

What is claimed is:

1. A method for forming a giant magnetoresistive (GMR) sensor element comprising:

forming a seed layer over a substrate, the seed layer being formed of a magnetoresistive resistivity sensitivity enhancing material selected from the group consisting of nickel chromium alloys, nickel -chromium-copper alloys and nickel-iron-chromium alloys;

forming a metal oxide buffer layer over the seed layer; said metal oxide buffer layer comprised of NiO or alpha Fe_2O_3;

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forming a free ferromagnetic layer over said metal oxide buffer layer;

forming a non-magnetic conductor spacer layer over said free ferromagnetic layer;

forming a pinned ferromagnetic layer over the non-magnetic conductor spacer layer ; and

forming a pinning material layer over the pinned ferromagnetic layer 18; and

forming a capping layer over said pinning material layer.

2. The method of claim 1 which further includes: forming a high conductivity layer (HCL) on said metal oxide buffer layer and forming said free ferromagnetic layer on said high conductivity layer (HCL) thereby creating a spin filter giant magnetoresistance (GMR) sensor element.

3. The method of claim 1 which further includes: forming a high conductivity layer (HCL) on said metal oxide buffer layer and forming said free ferromagnetic layer on said high conductivity layer (HCL); said high conductivity layer is comprised of Cu or a Cu-Ni alloy and has a thickness between 10 and 30Å, thereby creating a spin filter giant magnetoresistance (GMR) sensor element.

4. The method of claim 1 wherein said pinned ferromagnetic layer is composed of a three layer structure comprising: (a) a lower AP layer, (b) a non-magnetic conductor spacer layer and (c) an upper AP layer wherein said a non-magnetic conductor spacer layer induces anti-ferromagnetic coupling between said lower AP layer and said upper AP layer which enhances the Pinning effect.

5. The method of claim 1 wherein said pinned ferromagnetic layer is composed of a three layer structure comprising: (a) a lower AP layer, a Ru layer and a upper AP layer wherein said Ru layer induces anti-ferromagnetic coupling between said lower AP layer and said upper AP layer which enhances the Pinning effect and where said lower AP layer and said upper AP layer have a thickness of between about 5 and 20 Å and are comprised of CoFe and said Ru layer has a thickness of between about 5 and 10 Å.

6. The method of claim 1 wherein said seed layer is comprised of: NiFeCr.

7. The method of claim 1 wherein said metal oxide buffer layer is comprised of alpha - Fe_2O_3 and has a thickness of between about 5 to 15 Å.

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8. The method of claim 1 wherein said free ferromagnetic layer is comprised of: CoFe, CoFe/NiFe, Co/NiFe and has a thickness of 20 to 30 Å.

9. The method of claim 1 wherein said non-magnetic conductor spacer layer is composed of Cu having a thickness of between about 20 and 30 Å .

10. The method of claim 1 wherein the free ferromagnetic material layer and the pinned ferromagnetic material layer are each formed of a ferromagnetic material selected from the group consisting of nickel, iron and cobalt ferromagnetic materials, alloys thereof, laminates thereof and laminates of alloys thereof.

11. The method of claim 1 wherein said pinned ferromagnetic layer is comprised of a material selected from the group consisting of CoFe, and Co; and has a thickness of between about 10 and 30 Å.

12. The method of claim 1 wherein a pinning material layer is comprised of a material selected from the group consisting of MnPt, IrMn, and MnNi.

13. The method of claim 1 wherein said capping layer consists of a material selected from the group consisting of: MiFeCo, NiCr, and Ta , and has a thickness of between about 40 and 60 Å.

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14. The method of claim 1 wherein the spin filtering giant magnetoresistive (GMR) sensor element is selected from the group consisting of simple spin valve magnetoresistive (SVMR) sensor elements, synthetic antiferromagnetically biased giant magnetoresistive (GMR) sensor elements, simple spin filter giant magnetoresistive (GMR) sensor elements and spin filter synthetic antiferromagnetically biased giant magnetoresistive (GMR) sensor elements.

15. ~~A~~ method for forming a spin filter giant magnetoresistive (GMR) sensor element comprising:

forming a seed layer over a substrate, said seed layer being formed of a magnetoresistive resistivity sensitivity enhancing material selected from the group consisting of nickel chromium alloys, nickel -chromium-copper alloys and nickel-iron-chromium alloys;

forming a metal oxide buffer layer over the seed layer; said metal oxide buffer layer comprised of NiO or alpha $Fe2O_3$;

forming a high conductivity layer on said metal oxide layer;

forming a free ferromagnetic layer over said high conductivity layer;

forming a non-magnetic conductor spacer layer over said free ferromagnetic layer;

forming a pinned ferromagnetic layer over the non-magnetic conductor spacer layer ; and

forming a pinning material layer over the pinned ferromagnetic layer;

forming a capping layer over said pinning material layer.

16. The method of claim 15 which further includes: said high conductivity layer is comprised of Cu or Cu-Ni and has a thickness between 10 and 30Å.

17. The method of claim 15 wherein said pinned ferromagnetic layer is composed of a three layer structure comprising: (a) a lower AP layer, a non-magnetic conductor spacer layer and a upper AP layer wherein said non-magnetic conductor spacer layer induces anti-ferromagnetic coupling between said lower AP layer and said upper AP layer which enhances the Pinning effect.

18. A spin valve giant magnetoresistance (SVGMR) sensor comprising:

a seed layer over a substrate, said seed layer being formed of a magnetoresistive resistivity sensitivity enhancing material selected from the group consisting of nickel chromium alloys, nickel -chromium-copper alloys and nickel-iron-chromium alloys;

a metal oxide buffer layer over the seed layer; said metal oxide buffer layer comprised of NiO or alpha Fe_2O_3;

a free ferromagnetic layer over said metal oxide buffer layer;

a non-magnetic conductor spacer layer over said free ferromagnetic layer;

a pinned ferromagnetic layer over the non-magnetic conductor spacer layer ; and

a pinning material layer over the pinned ferromagnetic layer; and

a capping layer over said pinning material layer.

19. The spin valve giant magnetoresistance (SVGMR) sensor of claim 18 which further includes: a high conductivity layer on said metal oxide buffer layer and said free ferromagnetic layer on said high conductivity layer .

20. The spin valve giant magnetoresistance (SVGMR) sensor of claim 18 which further includes: a high conductivity layer on said metal oxide buffer layer and said free ferromagnetic layer on said high conductivity layer (HCL); said high conductivity layer is comprised of Cu or Cu-Ni and has a thickness between 10 and 30Å.

21. The spin valve giant magnetoresistance (SVGMR) sensor of claim 18 wherein said pinned ferromagnetic layer is composed of a three layer structure comprising: (a) a lower AP layer, (b) a non-magnetic conductor spacer layer and (c) an upper AP layer wherein said non-magnetic conductor spacer layer induces anti-ferromagnetic coupling between lower AP layer and upper AP layer which enhances the pinning effect.

22. The spin valve giant magnetoresistance sensor of claim 18 wherein said pinned ferromagnetic layer is composed of a three layer structure comprising: (a) a lower AP layer, (b) a Ru layer and (c) an upper AP layer wherein said Ru layer induces anti-ferromagnetic coupling between said lower AP layer and said AP upper which enhances the pinning effect and

where said lower AP layer and said upper AP layer have a thickness of between about 5 and 20 Å and are comprised of CoFe and said Ru layer has a thickness of between about 5 and 10 Å

23. The spin valve giant magnetoresistance sensor of claim 18 wherein said seed layer is comprised of: NiFeCr.
24. The spin valve giant magnetoresistance sensor of claim 18 wherein said metal oxide buffer layer is comprised of alpha - Fe_2O_3 and has a thickness of between about 5 to 15 Å.
25. The spin valve giant magnetoresistance sensor of claim 18 wherein said free ferromagnetic layer is comprised of: CoFe, CoFe/NiFe, Co/NiFe and has a thickness of 20 to 30 Å.
26. The spin valve giant magnetoresistance sensor of claim 18 wherein said non-magnetic conductor spacer layer is composed of Cu having a thickness of between about 20 and 30 Å .
27. The spin valve giant magnetoresistance sensor of claim 18 wherein the free ferromagnetic material layer and the pinned ferromagnetic material layer are each formed of a ferromagnetic material selected from the group consisting of nickel, iron and cobalt ferromagnetic materials, alloys thereof, laminates thereof and laminates of alloys thereof.
28. The spin valve giant magnetoresistance (SVGMR) sensor of claim 18 wherein said pinned ferromagnetic layer is comprised of a material selected from the group consisting of CoFe, and Co; and has a thickness of between about 10 and 30 Å.
29. The spin valve giant magnetoresistance (SVGMR) sensor of claim 18 wherein a pinning material layer is comprised of a material selected from the group consisting of MnPt, IrMn, and MnNi; and has a thickness of between about 50 and 300 Å.
30. The spin valve giant magnetoresistance (SVGMR) sensor of claim 18 wherein said capping layer consists of a material selected from the group consisting of: MiFeCo, NiCr, and Ta , and has a thickness of between about 40 and 60 Å.

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